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ECONOMICS OF PUBLIC WATER PRICING

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ECONOMICS OF PUBLIC WATER PRICING

by

Michael F. Brewer[1]

Introduction

A substantial chapter of economic theory has focused on the pricing of publicly produced goods and services. Its empirical counterpart, manifest in public utility rate rulings, enabling legislation of governmental agencies, and administrative dicta originating within other public groups, includes a wide variety of pricing methods. Pricing policy explicitly has been recognized as an integral aspect of public programs for the development and management of natural resources in general and of water in particular.

Several federal agencies, including the U. S. Bureau of Reclamation, have well-established policies governing their pricing practices. Other public agencies are in the process of formulating such policies, and the propriety of particular pricing methods has been the subject of considerable argument. The development of relevant criteria and their application in the evaluation of specific pricing alternatives constitute the main theme of this study.

Often several "publics" participate in water development. Federal agencies, federations of public districts, counties, and local water districts may all be involved in the impoundment of water, its transportation, and its distribution to eventual consumers. Water rights and/or water service commitments are transferred through this chain of organizations. Analyzed in this study are five pricing methods which may be used in the transfer of water from a regional agency's distribution system to local groups. These, in turn, provide the necessary physical facilities and the administrative organization for subsequent distribution to individual users. "Regional agency" thus may be regarded as a water wholesaling body and "local groups" as retailing entities.

Although regional water development by nonfederal agencies has been limited in the United States, it may be expected to become more important in the future. Two factors support this expectation: (1) the inadequacy of local

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1/ Assistant Professor of Agricultural Economics and Assistant Agricultural Economist in the Experiment Station and on the Giannini Foundation.

organizations to provide additional water for the growing population and water-using activities within their respective service areas; and (2) an increase in area-wide water planning activity.

Local water development institutions have had a long and generally successful history in the arid and semiarid parts of the United States. While adequate for the development of single watersheds, they generally have not been able to encompass interbasin water transfer.[1] Local organizations often lack the capacity to meet the financial requirements of such regional development and distribution activites, and their structure frequently does not lend itself to the type of integrated management entailed.[2] A regional agency logically is looked to under such circumstances.

Water planning activities also have emphasized regional agencies for water development and wholesaling. Until recently, the lack of sufficient physical and economic data[3] have prevented broad participation in these activities by nonfederal regional agencies. This deficiency gradually is being overcome by an increased emphasis on natural resources management problems in institutions of technical instruction and data-gathering agencies. Many state governments,[4] too, have been stimulated to participate actively in water development planning.

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[1] Notable exceptions exist such as the Metropolitan Water District of Southern California and the cities of San Francisco and Los Angeles.

[2] For a discussion relating the structure of water organizations to programs of water management, see: Stephen C. Smith, "Problems in the Use of the Public District for Ground-Water Management," Land Economics, vol. XXXII, no. 3, August, 1956, pp. 259-269.

[3] Data compiled by federal agencies have been inadequate because of two principal reasons: Federal service areas did not coincide with state planning regions, and federal data are used to justify a particular project, whereas regional water development frequently entails a schedule of development activities designed to take place over long periods of time. Thus, the state of California began in 1947 to gather data particularly suited to state water development. See: California Water Resource Board, Water Resources of California, Water Resources Bulletin No. 1 (Sacramento, 1951), p. 11. (Letter of Transmittal.)

[4] Although most state water agencies have had predominantly regulatory functions, recent legislation has formed several agencies with water development planning responsibilities. The California Department of Water Resources was created in 1956. Colorado and Idaho in 1957 created new Departments of Natural Resources including Divisions of Water Resources. Legislation also adopted in 1957 created a new Department of Conservation and Natural Resources with a Division of Water Resources headed by the state engineer in Nevada. An Oregon Water Resources Board was created in 1955, responsible for developing a state water plan for the use and control of water resources and classification of state waters for this purpose. See: The Council of State Governments, State Administration of Water Resources (Chicago, 1957), p. 153.

Current proposals of the state of California to construct, finance, and administer a statewide water development plan[1] are used to provide substance for the analysis pursued in this discussion. This plan includes a series of dams and reservoirs on northern California streams and a system of aqueducts and pumping stations, known as the California Aqueduct System, to distribute the regulated flow throughout the state. Completion of the first project of the California Water Plan--The Feather River Project--would produce an estimated 4 million acre-feet of water for annual distribution through the California Aqueduct System. Of this, the predominately agricultural southern San Joaquin Valley area is expected to receive some 1.8 million acre-feet or 32 per cent of the total annual delivery from the system. It is estimated that 53 per cent[2] will be pumped over the Tehachapi Mountains, the southern terminus of the interior Central Valley of California, for use in the southern California coastal plain and coastal San Diego County.

Current proposals envisage the contracted delivery of this water from the state's aqueduct system to local organizations, of which the California irrigation district may be considered the prototype. These districts in turn will serve their members from the contracted supply through their own distribution facilities.

A state water pricing method explicitly defines the conditions for water exchange between the state and the water districts. Although this exchange represents a "wholesale" transaction, the conditions which are established influence the financial position of local districts. This in turn bears upon the "retail" pricing methods they employ and thus affects utilization of the water by eventual consumers. An understanding of the functions of price throughout this process is basic to the identification of relevant criteria whereby the adequacy of alternative methods may be assessed.

Section I of this paper describes the structure of the California water "market" and analyzes the role of price therein. Criteria derived from the

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[1] See: California Department of Water Resources, The California Water Plan, Water Resources Bulletin No. 3 (Sacramento, 1957), 246p.

[2] See: California Department of Water Resources, Preliminary Report on Investigation of Alternative Aqueduct Systems to Serve Southern California, Water Resources Bulletin No. 78 (Sacramento, 1959), Tables 14, 16, and 18.

analysis are used to evaluate several different pricing methods in Section II. This functional evaluation is extended to embrace broader policy considerations in the final section.

I. The Water Market and Water Payments

The Water Industry and Market

By economic convention, the "water industry" alludes to firms producing water. Familiar problems of connoting a heterogeneous resource by such a definition are apparent. Water presents a broad qualitative spectrum--from sewer effluent to a chemical distillate--and its classification for purposes of transaction embodies broad criteria. Class I and II water are specified by the Bureau of Reclamation on the basis of probability of annual delivery, whereas some districts differentiate "treated" from "untreated" water, and others make a distinction on a delivery elevation basis. The availability of water from a particular source for given uses and users is partially determined by such institutions as water rights law and water organizations. Demand elasticity and cross-elasticity also are affected by these institutions.

The "producing firm" of this industry presents additional conceptual difficulties. The water industry is concerned with the development of a regulated flow of usable water. Here again, significant institutional qualifications exist, for such development must not illegally violate existing rights to water use.1/ Water production means making available for export or in situ use water otherwise unavailable within the existing institutional context. An organization facilitating such use thus "produces" water. The production function explicitly includes institutional parameters.

The water industry thus emerges as a much qualified concept, useful for exposition but hardly susceptible to relevant analysis by the definitions and tools of conventional industrial analysis.2/

1/ Under California water rights law, appropriative, riparian, and correlative rights may be violated legally by open, continuous adverse use. Such use over a designated period of time may establish prescriptive rights to the adverse user. See: Wells A. Hutchins, The California Law of Water Rights (Sacramento: State Print. Off., 1956), pp. 284-243.

2/ This term connotes the methodology based upon Stackelberg's approach to market analysis. See: Heinrich Stackelberg, The Theory of the Market Economy, translated from the German and with an introduction by Alan T. Peacock (1st German ed., 1943; New York: Oxford University Press, 1952).

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I. The Water Market and Water Payments

The Water Industry and Markets

By economic convention the "water industry" embraces facilities producing water. Familiar problems of describing a heterogeneous industry by such a definition are apparent. Water presents a broad qualitative spectrum--from sewer effluent to a chemical distillate--and its classification for purposes of transaction embodies broad criteria. (Class I and II water are specified by the Bureau of Reclamation on the basis of probability of annual delivery; numerous districts differentiate "treated" from "untreated" water, and others make a distinction on a delivery schedule basis. The availability of water from a particular source for given time and place is partially determined by institutions--water rights law and other organizations. Hence, flexibility and cross-elasticity also are affected by these institutions.

The "producing firm" of this industry presents additional conceptual difficulties. The water industry is concerned with the development of a continued flow of usable water. Here again, significant institutional qualifications exist, for such development must not illegally violate existing rights to water use.[1] Hence ground-water basins making available for supply or in lieu use water otherwise unavailable within the existing institutional context. An organization facilitating such use thus "produces" water. The production function explicitly includes institutional components.

The water industry thus emerges as a much qualified concept, useful for exposition but hardly susceptible to rigorous analysis by the methodology and tools of conventional industrial analysis.[2]

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[1] Under California water rights law, appropriative, riparian, and prescriptive rights may be violated legally by open, continuous, adverse use. Such use over a designated period of time may establish prescriptive rights to the new water user. See: Wells A. Hutchins, The California Law of Water Rights (Sacramento: State Print. Off., 1956), pp. [illegible].

[2] This term connotes the [illegible] Stackelberg's approach to market analysis. See: Heinrich von Stackelberg, The Theory of the Market Economy, translated from the German and with an introduction by Alan T. Peacock (London: [illegible], 1952; New York: Oxford University Press, 1952).

A "market" is defined about the interaction among buyers and sellers. Properly described, it identifies the process of tenure transactions from producer to consumer, the institutions facilitating this process, and the conditions of exchange, or the exchange ratios, prevailing at each stage.

Qualifications to conventional usage of this term are immediately apparent. Producers and sellers are not numerically equivalent. Some producers exclusively wholesale water as does the U. S. Bureau of Reclamation through the Central Valley Project. Others both wholesale and retail as do local irrigation districts. The dominant qualification of the California water market is its size relative to the industry. Approximately 60 per cent of California's irrigation water supply is consumed by producers without direct recourse to any form of water market.1/ Most of this is pumped ground water and is supplemental to other available sources. The aggregate of this joint production-consumption is therefore partially determined by the prices prevailing for water transactions occurring within the market. Actions of the producer-consumer also affect this price through demand cross-elasticity and thus are a major extramarket influence that must be reckoned with for an understanding of water price behavior.

These admitted difficulties notwithstanding the term "water market" retains expository value for the analysis pursued here. As previously indicated, this analysis uses the California Water Plan as its major example. The state of California is the producer and wholesaler, the public water district is the wholesale buyer, and members of local districts are the consumers.

Price and the Water Market

The meaning of "water price," or more properly, "water payments," may be examined within this context. This term is used to introduce the possibility of periodicity of payments, their change in magnitude, and a variety of forms which may be required by payment contract. Payment transactions between local agencies and their members likewise may vary in timing and form.

Direct water sale receipts2/ made in connection with these transactions comprise only a part of the total revenue that may accrue to the local agency

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1/ See: U. S. Bureau of the Census, United States Census of Agriculture: 1950 Irrigation of Agricultural Lands, The United States (Washington, 1952), vol. III, p. 3-3.

2/ Technically, this is the receipt of payments for water service, or water rental receipts, as there is no transference of a water right.

or state. For local districts, assessment and the transfer of funds representing payment for services other than water supply are additional revenues.[1] The size of these fund transfers frequently are related immediately to the direct water payments required of district members. At the state level, legislative provision has been made for a similar transfer of funds--in the form of Tideland Oil fund monies[2]--and the possibility of employing assessments at this level has not been ruled out. Thus, total revenues to both the district and state may take the form of: (1) receipts from water sales as specified in contracts or by a district board of directors, (2) assessment receipts, and (3) fund transfers from other activities of the unit.

From these categories of revenue items, a distinction may be made among three substantive problem areas: (1) price, (2) payments, and (3) financing. Price problems allude to the processes behind the accumulation of sales receipts. A price decision implies a designation of the requisite cost conditions for water transfer. Payment refers both to the sales receipts and assessment receipts accounts and the processes they involve. Financing is most general, referring to all three categories of revenue. Although, in the interest of brevity, the problem of financing at the state level is not directly considered, the relationship between state pricing and financing at the local retailing level must be made explicit.

Evaluative criteria are needed to assess the several pricing methods considered. These criteria must permit a preference ordering of a set of considered alternatives.[3] They may be specified on the basis of a priori value assertions or from a pragmatic approach to the pricing process itself.[4] Public

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[1] The California irrigation district and most other forms of public water districts have the power of member assessment. Those that engage in functions that produce other vendable goods or services, notably electrical power, often transfer any surplus incurred to their water accounts in a manner comparable to the basin account procedure of the U. S. Bureau of Reclamation.

[2] California Assembly Bill No. 1062, signed by the Governor on April 18, 1959, as Chapter 140.

[3] Frequently, the set of alternatives consists of an "either" and an "or" member. Quite general criteria will suffice for their preference ordering. A larger set of alternatives would require either a more specific criterion or a larger number of general-order criteria for such ordering. In the latter instance, most of the criteria may be in the form of constraints imposed on a general-order criterion.

[4] For a discussion of these two approaches, see: Frederic O. Sargent, "A Methodological Schism in Agricultural Economics," Canadian Journal of Agricultural Economics, vol. VII, no. 2, November, 1960, pp. 45-52.

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pricing policy is manifest through legal and administrative institutions which can be appraised relevantly by examination of their functions and selection of appropriate criteria. The plural functions of water payments imply separate criteria for each level at which the costs or revenues inherent in payment procedures are incident. Three levels are suggested by the water market--regional, local, and consumer.

Payments at the Regional Level

The basic economic purpose of a regional plan of water development is to facilitate continuous enlargement of the real income of the respective region.[1] Attempts to substitute real income optimization in a static, cross-sectional sense have been abortive.[2] A number of conditions and constraints surrounding this basic objective are important. Three of these have been enunciated in connection with the California Water Plan: (1) no reduction in the state's credit position, (2) payment by beneficiaries, and (3) a prevention of "unjust enrichment." The role of payments is discussed in connection with each.

Early proponents for state water development emphasized the desirability of a self-liquidating financing program,[3] and this initial emphasis has been pricing policy is manifest through legal and administrative institutions which can be appraised relevantly by examination of their functions and selection of appropriate criteria. The plural functions of water payments imply separate criteria for each level at which the costs or revenues inherent in payment procedures are incident. Three levels are suggested by the water market--regional, local, and consumer.

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[1] A general economic objective of the California Water Plan has been stated as "securing the maximum benefit to all areas and peoples of the State"--California Department of Water Resources, The California Water Plan (Sacramento, 1957), p. xxv. This statement needs to be modified if it is to serve as an operational economic criterion for public investment. The real income of the state is suggested as such a relevant concept. Although not explicitly stated, the enhancement of state income underlies the reasoning invoked by the California Department of Water Resources in meeting future "requirements." See: California Water Resources Board, "A Preliminary Projection of California Crop Patterns for Estimating Ultimate Water Requirements," Water Utilization and Requirements of California, Appendix A (Sacramento, 1955).

The original statement implies a first order homogeneous function of state income, the validity of which has been subject to considerable discussion. See: Karl Brandt, "Problems in Planning for Future Demand of Water," Economics of California's Water Development, edited by S. V. Ciriacy-Wantrup and Stephen C. Smith, University of California, Committee on Research in Water Resources (Berkeley, 1958), pp. 7-21.

[2] An optimization criterion has been shown to have substantial shortcomings (S. V. Ciriacy-Wantrup, "Concepts Used as Economic Criteria for a System of Water Rights," Land Economics, vol. XXXII, no. 4, November, 1956, pp. 295-312). Furthermore, the practical desirability of a highly refined formulation of an economic optimum has been questioned recently. See: S. Tolley, "McKean on Government Efficiency," The Review of Economics and Statistics, vol. XLI, November, 1959, pp. 446-448.

[3] California Department of Water Resources, The California Water Plan, p. 226.

Payments at the Regional Level

The basic economic purpose of a regional plan of water development is to facilitate continuous enlargement of the real income of the respective region.[1] Attempts to substitute real income optimization in a static, cross-sectional sense have been abortive.[2] A number of conditions and constraints surrounding this basic objective are important. Three of these have been enunciated in connection with the California Water Plan: (1) no reduction in the state's credit standing, (2) payment by beneficiaries, and (3) a prevention of "unjust enrichment." The role of payments is discussed in connection with each.

Early proponents for state water development emphasized the desirability of a self-liquidating financing program,[3] and this original emphasis has been accepted as an official position with regard to the California Water Plan.[1] Two interpretations of the phrase appear possible: that the state's water budget should remain in a solvent position; and that the state, as a bond debtor, should not assume a major part of the risk that a position of solvency may not be attained.[2]

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[1] A general economic objective of the California Water Plan has been stated as "providing the maximum benefit to all areas and people of the state." California Department of Water Resources, The California Water Plan (Sacramento, 1957), p. xxx. This statement needs to be qualified if it is to serve as an operational economic criterion for public investment. The real income of the state is suggested as such a relevant concept. Although not explicitly stated, the enhancement of state income underlies the reasoning invoked by the California Department of Water Resources in meeting future "requirements." See California Water Resources Board, "A Preliminary Projection of California's [illegible] Patterns for Estimating Ultimate Water Requirements," Water Utilization and Requirements of California, Appendix A (Sacramento, 1955).

The original statement implies a fixed order homogeneous function of water income, the validity of which has been subject to considerable discussion. See [illegible], "Problems in Planning for Future Demand of Water," Economics of California's Water Development, edited by S. V. Ciriacy-Wantrup and [illegible] C. Smith, University of California, Committee on Research in Water Resources (Berkeley, 1957), pp. 7-21.

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[3] California Department of Water Resources, The California Water Plan, p. 226.

The first interpretation embodies economic criteria similar to those associated with the conventional test of financial feasibility. Construed generally, it maintains that revenues to the project authority must be adequate to permit payment of interest and principal of those project costs termed "reimbursable," as well as payment of current expenses, without resort to general taxation[3] or funds secured therefrom. Although the Plan's broad public benefits have been emphasized, no policy defining specific nonreimbursable costs yet has emerged. Presumably, costs so classified could be met from general taxation revenues without violating this condition. The second interpretation becomes especially important in light of the long period of indebtedness that reasonably might be anticipated in connection with regional water development programs. It merely asserts that the probability be acceptably low that unfavorable future economic conditions[4] incident on the regional authority will cause a drain on public funds.

From the outset of discussion on the California Water Plan, the principle that beneficiaries pay has been consistently espoused, although it too has been subject to various interpretations. One group of advocates holds that the payment be designated to maximize the return to the state. This has been suggested

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[1] California Department of Water Resources, Preliminary Report on Investigation of Alternative . . ., p. VII-5.

[2] See statement of the Public Utility Commission of the City and County of San Francisco presented before the California Senate Water Fact Finding Committee by James H. Thurber, General Manager and Chief Engineer, San Francisco Water Department, and Harvey E. Lloyd, Manager and Chief Engineer of Hetch Hetchy Water Supply, Power, and Utilities Engineering Bureau, October 9, 1959, Sacramento, California.

[3] This relates to taxes of statewide incidence such as income or excise tax receipts. It should be noted that express provision has been made for local taxation imposed by agencies contracting for deliveries from the California Water Plan. See: California Department of Water Resources, Contracting Principles for Water Service Contracts Under the California Water Resources Development System (Sacramento, 1960), item no. 13.

[4] This includes all future eventualities that weaken the ability-to-pay or increases the costs of the entire plan.

for project power sales but has been held relevant also for water sales to irrigation and other user groups.[1] A second interpretation advocates payments proportional to benefits received, with total payments by beneficiaries being equal to, but not in excess of, total project costs, including interest on bonded debt.[2] One argument used in connection with this proposition has been the avoidance of "unjust enrichment." The relationship between these two arguments is considered below. A third version of beneficiary payment considers only reimbursable benefits.[3] For present purposes, the magnitude of aggregate payments is not of primary significance. Their adequacy in terms of aggregate size is more directly appraised by criteria pertaining to the protection of state credit. The general principle of beneficiary payment, on the other hand, may be measured by or compared with a standard in which payment is proportional to benefits received.

Private benefits in excess of costs are considered as a form of enrichment resulting from the projects. General concern has been expressed over the incidence and magnitude of such private benefits. Avoidance of "unjust enrichment" has been a widely accepted condition for pricing and other aspects of project administration.

Two basic ways in which regional water development may affect the private benefits realized by individuals within the agricultural sector of the region's economy are important in this connection--through the returns from production and land values. Since these benefits may assume any of a variety of forms, enrichment from participation in regional water development may be considered as positive changes in the net worth of individuals. The "justness" of individual enrichment is subject to various interpretations,[4] but its determination

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[1] See statement presented before the California Senate Water Fact Finding Committee by the Riverside County Water Authority, October 8, 1959, Sacramento, California.

[2] See statement presented before the California Senate Water Fact Finding Committee by William R. Seeger, General Manager and Chief Engineer of the Marin Municipal Water District, San Rafael, California, October 9, 1959, Sacramento, California.

[3] See statement presented before the California Senate Water Fact Finding Committee by James F. Wright, Chief Deputy Director of the California Department of Water Resources, November 20, 1959, Los Angeles, California

[4] Any of the following would serve as criteria for such determination:

1. A broad distribution of benefits in terms of some a priori standards.
2. Project costs (either total or some designated portion thereof) are repaid by beneficiaries (direct or indirect).
3. The capture of the increment in individual net worth of beneficiaries in excess of an absolute amount.
4. The capture of a designated portion (percentage) of the increment to individual net worth. This is comparable to capturing enhancement per acre in excess of an absolute amount.

is not essential for purposes of evaluating alternative pricing methods. The extent to which a particular method permits the adjustment of enrichment, in terms of incidence and/or over-all magnitude, is of direct relevance, however.

Payments and the Local District

The ability of the local district to change the size and composition of member payments provides a tool for achieving water allocation objectives as well as a source of revenue. As the certainty of income streams from different forms of payment varies, its composition has direct bearing on the district's financial position.

The various functions of payment and the relatively wide degree of latitude afforded public water districts under California law in this respect have been noted.[1] Although specific payment decisions will depend on particular attributes of individual districts, general criteria may be ascertained.

The provision of water at least cost to members is a prime constituent interest. In this regard, the nonprofit nature of the districts, their power to issue bonds, and the technical economies of large-scale development and distribution facilities are advantages of this form of organization. When districts are so constituted that physical interrelationships among different water sources used by its members entail joint costs, district pricing practices, although directly related to district water deliveries alone, may also affect the costs of obtaining water from other sources. Under such circumstances, district pricing must be evaluated in terms of the entire water system available to members.

Retail pricing practices may result in different charges to individual members for similar amounts of water. Under such circumstances, being unable to disassociate from the organization at will, these individuals may form factions or dissension groups. These may be sufficiently numerous and powerful in terms of member voting blocs that district administration becomes unwieldy and difficult. In California, the development of such factions has resulted in the replacement of district-wide development programs by smaller, localized units, organized and financed through individual improvement districts within

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[1] Michael F. Brewer, Water Pricing and Allocation with Particular Reference to California Irrigation Districts, University of California, Giannini Foundation Mimeographed Report No. 235 (Berkeley, October, 1960). See particularly chapter III, pp. 34-77.

the same parent irrigation district. The extent to which different pricing practices avoid or tend toward equity problems thus may be posited as a relevant internal evaluative criterion.

Additional criteria pertain to the effects of pricing on district solvency and to the status of a district's water rights. Under California law, both the extent and type of water use by members of a district may affect the tenure uncertainty of these rights, principally in terms of their jeopardy to prescriptive capture.[1]

Payments and the Water Consumer

The type of payment adopted by a district for its members shapes their water use decisions.[2] The district assessment may be considered a fixed cost for annual production decisions as it is based upon unimproved property. The water toll, on the other hand, is a variable production cost. So long as member demand elasticity is less than infinity, tolls of different sizes will induce use of different quantities of the district supply. Thus, the form and size of payments set by a local district will partially determine the length and direction of the water input vector[3] for irrigation production within the boundaries of that district.

Often, additional noncost allocating devices are used. Rotational delivery, necessitated by the limited capacity of distribution systems, effectively imposes an upper volume limit on individual deliveries. Prorating methods of water rationing for those years in which effective water demands exceed supply have been adopted by most water districts. In spite of these provisions, the direct consideration of water costs in production decisions renders the payments schedule a tool for allocating local water supplies.

The irrigating member of a local district that is a potential contractee for regionally developed water judges regional pricing on the basis of the

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[1] The prescriptive water right is a legally recognized right to the use of water. It may be obtained by open, adverse use of appropriative or other prescriptive rights for a designated period of time. In California, this period is three years.

[2] Brewer, "Repayment and Product Pricing in Small Watershed Development," Water Resources and Economic Development of the West: Small Watershed Development, Rehabilitation and Reorganization of Irrigation Projects (Berkeley, 1958), pp. 45-60. (Report No. 6, Conference Proceedings of the Committee on the Economics of Water Resources Development, University of California).

[3] For a pioneering study that applied this term to economic analysis, see: Ciriacy-Wantrup, "Economics of Joint Costs in Agriculture," Journal of Farm Economics, vol. XXIII, no. 4, November, 1941, pp. 771-818. Considerations of water quality are particularly important additional determinants of the factor input vector. The general problem of quality has been abstracted from this discussion in the interest of brevity.

payment schedule adopted by his district. A regional pricing method is deemed acceptable if it permits use of the enlarged district water supply at a profit. This may result from an expansion of irrigated acreage, from a shift to more intensive irrigation practices, or from a substitution of a lower cost water source for a higher cost source.

II. Economic Analysis of Pricing Methods

A pricing method is considered as a general formulation of price. The methods discussed do not by themselves establish a numerical price; however, they do identify the major variables in a price function and are susceptible to comparative evaluation.

Although one can conceive of innumerable major variables about which a price function may be defined, and indeed actual pricing methods demonstrate remarkable variety, a basic classification is nevertheless suggested. Three factors stand out as having been dominant variables to public water pricing decisions: location of delivery (in relation to the head of a surface distribution system), the type of use to which water is put, and time.

Price may be systematically related to any or all of these variables or it may be functionally unrelated. It is not necessary to analyze each of the possible combinations. Of the specific pricing methods considered, the first four have been discussed widely in connection with public water development projects:

1. Postage stamp pricing.
2. Differentiation by types of water use.
3. Zonal price differentiation.
4. Price variations over time.
5. Benefit pricing.

As defined, these methods are not necessarily mutually exclusive. Several may be used conjunctively; however, use of certain ones will preclude the simultaneous adoption of others. For instance, postage stamp pricing is inconsistent with zonal price differentiation, whereas it might be used jointly with price variability over time. Each of the methods discussed is appraised by reference to the functional criteria developed in the preceding section as well as by more formal criteria of economic efficiency.

Postage Stamp Pricing

This pricing method is characterized by an identical price for given water uses throughout the service area. The principal exponent of postage stamp pricing for water is the U. S. Bureau of Reclamation. Within a reclamation project, the same price is charged recipients (either districts or individuals) of water for agricultural purposes from any point on the distribution system.[1/] Similar practices have been considered for a state water pricing policy. This pricing method may be evaluated both from formal and functional standpoints.

Establishing a single price for a public service raises the problem of how the charge is to be determined. Federal reclamation projects determine a cost designed to generate sufficient water sales revenues over the project's life to cover a portion of allocated project costs termed "reimbursable." Federal accounting procedures frequently entail a write-off of certain reimbursable costs by fund transfer in multiple-purpose projects as well as involving interest-free capital. In the instance of the California Water Plan,[2/] more traditional arguments of marginal and average cost pricing appear pertinent as the write-off of project costs presumably will be kept to a minimum. This problem is parallel to that of public electric utility rate structures, and the not inconsiderable literature on this subject is relevant. A fundamental theoretical controversy at issue is incremental cost (or marginal cost) and average cost pricing.

Under certain conditions, economic theory demonstrates that marginal-cost pricing will result in an efficient allocation of goods so priced. Whether or not a similar case can be made for the price of water has been subject to question in the literature.[3/] The implied welfare criteria are those of a competitive market economy. This invokes assumptions of perfect foresight on the part of entrepreneurs and a long-run equilibrium such that for a given income distribution no subsequent transfer could increase the satisfactions of

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1/ There is a differentiation in price between Class I and Class II agricultural water. The first classification relates to a "firm" supply, the latter to a supply more susceptible to annual quantitative change. For the Friant-Kern and Madera Units of the Central Valley Project, Class I water is delivered canalside for $3.50 an acre-foot and Class II for $1.50.

2/ As used hereafter, the California Water Plan refers to the Feather River Project and the southern California Aqueduct System discussed earlier.

3/ W. K. McPherson, "Can Water Be Allocated by Competitive Prices?," Journal of Farm Economics, vol. XXXVIII, no. 5, December, 1956, pp. 1259-1268, and discussion by R. Barlowe, pp. 1279-1282.

one water user without reducing those of another. These conditions require a long-run production situation such that marginal cost equals average cost and both equal price. Certainly the instantaneous, competitive economic model has desirable analytical attributes, but is it applicable to water? Water developments units are hardly competitive in the way required, nor are the factors used perfectly divisible, permitting a situation in which no price would be possible such that it equals simultaneously marginal cost and average cost.

The central shortcomings of this pricing argument is that situations characterized by discrete change are represented in marginal terms. Marginal pricing distinguishes the dates of particular costs. Once factor opportunity costs have been paid, the argument runs, the producer need take no further account of them in deciding a current price. Thus, so long as a single factor is not perfectly divisible over time, losses occur under a marginal cost price. As has been pointed out by Wiseman,[1] the consequent planning interval for water development must be a common multiple of the length of the life of all productive factors. Any interval of different length would involve an arbitrary decision that the interval selected is one particularly relevant to the calculation of marginal cost and a value judgment that income should be redistributed over time in favor of the consumers of goods produced by factors of a given relative durability.

This charge has been parried by the adoption of the so-called investment principle.[2] This principle argues that marginal cost pricing be used to decide selling prices of goods or services in existence but that the investment necessary to create them initially may be considered justified only if a perfectly discriminating monopolist could recover his cost by perfect price discrimination, that is, if community benefits are in excess of community costs. The investment principle really begs the question for the problem of whether a particular decision is one of marginal pricing or of investment remains to be resolved on an arbitrary basis.

Average cost pricing has been another single price argument. It suggests a price which recovers all money outlays that could have been avoided if a product had not been produced. Its proponents have stressed the necessity of a price that induces investment in the perpetuation and expansion of existing one more user without reducing those of another. These conditions reconcile long-run production efficiency such that marginal cost equals average cost at [illegible] equal price. Certainly, the instantaneous, competitive economic model is a highly generalized abstraction, but is it applicable to water? Water development units are hardly competitive in the way required, nor are the factors used perfectly divisible, permitting a situation in which no price would be possible such that it equals simultaneously marginal cost and average cost.

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[1] This is pointed out by J. Wiseman. See: "The Theory of Public Utility Prices," Oxford Economic Papers, vol. 9, no. 1, February, 1957, pp. 56-74.

[2] As, for example, is done by B. P. Beckwith, Marginal Cost Price-Output Control (New York: Columbia University Press, 1955). See especially chapters VII and VIII.

The central shortcoming of this pricing argument is that situations characterized by discrete changes are represented in marginal terms. Marginal pricing distinguishes the dates of particular costs. Once an investment opportunity cost has been paid, the argument runs, the producer need take no account of them in deciding a current price. Thus, so long as a single factor is not perfectly divisible over time, issues occur under a marginal cost principle. As has been pointed out by Wiseman,[1] the consequent planning interval for water development must be a common multiple of the length of the life of all productive factors. Any interval of different length would involve an arbitrary decision that the interval selected is one particularly relevant to the calculation of marginal cost and a value judgment that income should be redistributed over time in favor of the consumers of goods produced by factors of a given relative durability.

This change has been met in by the adoption of the so-called investment principle.[2] This principle argues that marginal cost pricing be used to determine selling prices of goods or services in situations and that the investments necessary to create them initially may be considered justified only if a price discriminating monopolist could recover full costs by perfect price discrimination, that is, if community benefits are in excess of community costs. The investment principle really begs the question. For the problem of whether a particular decision is one of marginal pricing or of investment remains to be resolved on an arbitrary basis.

Average cost pricing has been another simple price argument. It suggests a price which recovers all money outlays that would have been avoided if output had not been produced. Its proponents have stressed the simplicity of a rule that induces interest in the performance and operation of existing plant and capacity. An incremental cost price would entail total sales receipts less than total production costs over rates of production characterized by decreasing average costs.

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[1] This is pointed out by J. Wiseman. See: "The Theory of Public Utility Price," Oxford Economic Papers, vol. 9, no. 1, February, 1957 pp. 56-74.

[2] As, for example, is done by [illegible], [illegible] (New York: Columbia University Press, 1953). See especially chapters VII and VIII.

This argument has been questioned[1] on the basis that some of the factors included in average cost pricing are fixed costs and that their inclusion prevents optimum welfare conditions. These conditions call for additional consumption at a price not greater than additional costs necessarily incurred in providing for that consumption. Average cost pricing would, therefore, curtail use before the optimum consumption rate was reached under conditions of decreasing average cost or would stimulate excessive investment in additional capacity under rates of production characterized by increasing average cost.

Other attributes of postage stamp pricing are important for a functional evaluation. These may be illustrated by reference again to the California Water Plan. Due to geographic dimensions, the total cost of water delivery increases as it is brought farther south in the state.

If water is purchased or contracts are signed at a single designated and fixed cost, the marginal value product presumably exceeds this magnitude. If postage stamp pricing is employed and related to total aqueduct costs, there is no indication when the marginal cost of the distribution facility is in excess of the marginal value product at southerly locations in the state and, thus, there is no safeguard against overexpansion of the facility.

A related objection is seen with regard to the unjust enrichment criterion. Under postage stamp pricing, a northern irrigator (assuming less favorable site and climatic conditions and thus a lower net return per acre) may have his consumer's surplus confiscated in greater degree than his more southerly counterpart. The northern irrigator, in fact, actually may be paying in excess of the marginal cost of providing water to his region, while southern farmers may experience a marginal value product less than the marginal cost of water supply. Under these circumstances, efficient production would require an expansion of northern production and a contraction of more southerly irrigated acreages. Motivation for this adjustment may be removed by the use of a single price based on total costs.

From an operational standpoint, a postage stamp pricing method offers few problems. Requirements for its application are delivery data and water use categories represented by contracting districts.

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[1] For example, see: James C. Bonbright, "Two Partly Conflicting Standards of Reasonable Public Utility Rates," American Economic Review, vol. XLVII, no. 2, May, 1957, pp. 386-393.

Differentiation by Type of Use

There is broad precedent for water pricing by type of use. The U. S. Bureau of Reclamation differentiates between municipal and industrial water and irrigation water sold from the Central Valley Project. Many irrigation districts employ domestic water rates different from those covering irrigation water service. Public utility commissions repeatedly have upheld rate differentiations on the basis of various costs of serving different uses.

From a regional standpoint, a differentiation of price among types of water use appears to enhance real income through optimal allocation if the difference factor is made proportional to the respective marginal value products of water in each use. If reliance can be placed on profit maximization motives of individual water users, this pricing tool would make higher charges incident on those most able to meet them and thus would strengthen the credit position of the state to a greater extent than would be true were postage stamp pricing adopted.

If various types of water use are envisaged as taking place within a typical Marshallian "firm," a price differentiated by productivity factors would satisfy the unjust enrichment criterion. Under these circumstances, consumer's surplus would be captured proportionately to the marginal value product of each use. Clearly, the assumption is inconsistent with the actual diversity of units within each use type. However, differential pricing by use requires a basic classification of uses. It may be also possible to classify users within each use type, depending upon available data.

In discussing the relevancy of this pricing tool to the California Water Plan, two positions have been advanced regarding the area over which such a differentiated price might be applied. One maintains that a given differential be made applicable for the entire state; the other argues for differentation among uses by differing region.

Because charges for agricultural water traditionally have been less than those for either domestic or municipal and industrial use, selection of the area within which such differentiation is effected has important cost incidence consequences. For example, ordinarily, a locally established differential would favor local agriculture if either or both of the following conditions obtain: the proportion of agricultural water use to industrial-domestic water use is relatively low or the land use pattern is characterized by high value nonagricultural land uses, such as industrial use or domestic subdivision. This stems from two relationships. The larger the relative quantity of higher priced water for nonagricultural purposes, the lower the price of agricultural

water for a given regional revenue target.[1] A related corollary lies in the economic shock absorbing effect of the higher priced water uses. The price for agricultural water would tend to be less sensitive to changes of a regional revenue target.

The second regional advantage attaches to the use of property assessment component of the retail water payment complex. Differences in property valuation systems for California irrigation districts have effectively been used to shift the incidence of total district costs (which may be considered total water costs) to urban areas. So long as local contracting agencies have member assessment powers,[2] the favorable tax base of areas such as southern California may be used to reduce the portion of total cost per acre-foot of delivered water paid by agriculture. This regional advantage becomes especially apparent when total regional payments to the state are tied to designated costs. With price differentials among use designated on a statewide basis, the resulting price ratios would be equal for all regions. Agriculture in areas with relatively low municipal and industrial use would gain the cost sharing advantage of the state average.

Contractual stipulations are required to assure effective compliance at the retail level with water payment differentiation designated by a regional authority. Two difficulties immediately present themselves at this point: the reduction

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1/ This assumes the ratio of unit price for nonagricultural water to that for agricultural use exceeds unity and the ratio of average variable unit cost of "producing" nonagricultural water service to that for agricultural service. If regionally allocated fixed cost per time period were A, the quantities of water used for agricultural and nonagricultural purposes, q_a and q_n respectively, and unit prices, p_a and p_n, then:

$$p_a = \frac{q_n}{q_a}(A-p_n), \text{ with } \frac{p_n}{p_a} = \text{a constant for each region.}$$

2/ Conceivably, the state could require through its water contracts that recipient organizations retail this water according to rate schedules and without recourse to assessment. On the other hand, the entire structure of local distributive organizations, such as public water districts, have traditionally had the power of member assessment. Furthermore, the flexibility afforded these local agencies by this price tool would be surrendered only reluctantly. The inequities arising from using this tool would have to be great indeed to warrant the loss of flexibility their abandonment would entail.

in district pricing flexibility entailed and the substitution of water from different sources within districts as a way of avoiding such resale stipulations.

Local irrigation districts have many factors to consider in determining a retail payments schedule. One such consideration relates to the management of the system of water available to the area served by a district. The payment complex may be used in a manner designed to induce use of a particular combination of water sources within the district that is consistent with the criterion of lowest total cost water over relatively long periods of time. Frequently, such water management programs entail the integration of ground water pumping with surface water use. In California and other states that do not have regulatory jurisdiction over the operation of privately owned pumping plants, the payment complex affords the public water district a useful tool for water management programs. As both the assessment and water toll components are administratively determined by the district, the variable unit cost of district water may be "set" in any desired relationship to the comparable cost for pumped ground water. In this manner, ground water may be rendered either a prime source or one supplemental to district delivered surface water. Thus, through the district organization, an entire area may be able to pursue water management activities generating benefits either so broad in their incidence or so future in their anticipated realization that individuals on their own initiative would not undertake them.[1/] Use of contractual resale stipulations would diminish the flexibility of district pricing and the ability to pursue such programs.

A second operational difficulty stems from the substitutability of district supplies. Were a district to receive only water from the California Water Plan, such contract stipulations could be made binding. When other water sources are available, not thus encumbered by contract, a substitution of sources for particular uses could render this pricing method ineffective.

To these considerations should be added the fact that districts are public bodies. The efficiency with which a district operates--establishes mechanisms for decision making, assembles a competent staff, obtains the degree of member agreement to permit the implementation of management programs, etc.--is related

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[1/] The Lower Tule River Irrigation District in California is pursuing such a program of ground-surface water use integration through the payment complex. See: W. A. Alexander, Lower Tule River Irrigation District: History and Operational Report, 1950-1957 (Woodville, California, 1957).

to the stability of the organization and its executive body. This stability has been the major consequence of the evolved equilibrium of political-economic forces and interests internal to these organizations.[1] The effects of different tools for state water price policy on a district's future organizational viability merits substantial consideration. A frequent basis for the separation of district members into factions is the type of water use activity in which they are engaged. Many districts found that the expansion of initially small urban centers within their boundaries required major readjustments in the operations of their water systems, pricing arrangements, and, in some instances, precinct redistricting for election purposes. The problems encountered and solutions pursued are unique to each individual district. A program of water price differentiation by type of use to the extent that contract stipulations require the adoption of new internal arrangements within the district undoubtedly would meet with district opposition and would place in jeopardy the political equilibrium they have evolved. Thus, although partial analysis indicates an increase in economic efficiency by such practices, its overassiduous implementation might disrupt local districts at substantial social and economic cost.

Zonal Price Differentiation

Proposals for a zonal differentiation of state water price for the California Water Plan have been made under the general heading of the "delta pool concept."[2] This concept differentiates between the production and distribution phases of the regional water plan. It entails the designation of an

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1/ For a case study of such an evolution, see: Smith, The Public District in Integrating Ground and Surface Water Management: A Case Study in Santa Clara County (manuscript to be published), 177p.

2/ This concept was initially presented in California Department of Water Resources, Preliminary Report on Investigations of Alternative Aqueduct Systems to Serve Southern California, Bulletin No. 78 (Sacramento, 1959), chapter VII. It recently has been more specifically defined in "Contracting Principles for Water Service Contracts Under the California Water Resources Development System," issued by the Department of Water Resources, January 20, 1960.

average acre-foot charge for water at the delta of the Sacramento and San Joaquin Rivers which subsequently is transported farther south by the California Aqueduct System. Zones are to be established along the southern course of this distribution system within which a single water price would prevail for contracting entities.[1] The zonal acre-foot cost will comprise a charge based upon the cost of facilities required to deliver water to each zone in addition to the designated delta charge.

Aqueduct costs are to be allocated to each such zone on the basis of the proportional-use-of-facilities cost allocation method. Other methods of cost allocation may be employed in connection with this pricing method, administration protestations notwithstanding.[2] For an aqueduct system, entailing scale economies, the problem becomes one of allocating negative joint costs--or joint benefits--among aqueduct reaches. If scale economies exist, the sum of the separable costs will be less than total aqueduct cost. The separable-cost-remaining-benefits method has been generally adopted by federal agencies for cost allocation among different project functions for which it holds distinct advantages.[3] Its use in connection with zonal pricing appears relevant, as

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[1] This abstracts from recently announced policy which would differentiate between the average unit cost of irrigation water used on large as opposed to small farms by a factor equal to the net power revenues averaged on an acre-foot of delivered water basis. This measure, purported to eliminate "unjust enrichment," contains ambiguities that make determination of the actual difference impossible.

[2] The separable cost remaining benefits method has been termed not applicable to the California Aqueduct System. See: William R. Gianelli, "Statement of the California Department of Water Resources Before the Senate Fact Finding Committee on Water," Contracts, Financing, Cost Allocations . . . for State Water Development (Sacramento: State Print. Off., March, 1960), p. 32.

[3] Separable cost remaining benefits method of cost allocation can never allocate more cost to a purpose than the benefits of the purpose nor less than its separable cost and, therefore, can never exclude a purpose whose benefits exceed separable cost. Moreover, it does not change the rank order of the benefit-cost ratios of the several purposes given by the more ideal ratio of benefits to separable costs. If benefits are computed so that they equal market values, the method insures that economically justified increments will be financially feasible. See: Richard Albin, The Problem of Cost Allocation in Multiple Purpose Water Use Projects, University of Chicago, Office of Agricultural Economics Research Paper No. 5605, Natural Resources Paper No. 11 (Illinois, January, 1956).

intrazonal deliveries may be considered different purposes of the entire "multi-purpose" aqueduct system.[1]

Absence of published data on the California Aqueduct System prevents a direct comparison between the two methods of cost allocation. It is possible, however, to infer the major difference. Use of the separable cost remaining benefits method would allocate larger portions of joint benefits to southern California than to the San Joaquin River Valley area. This is due to two attributes of the regions. First, the temporal bunching of irrigation demand requires a larger capacity structure per acre-foot delivered annually than the constant demand of municipal and industrial water which comprises a high proportion of anticipated southern California demand.[2] Second, the relatively larger share of total benefits accruing to southern California does not tend to decrease the portion of total joint benefits accruing to southern California employing the proportionate use of facilities method.

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[1] Whereas the separable cost remaining benefit method allocates positive joint costs in proportion to the ratio of remaining benefits of each project purpose to total remaining benefits, joint benefits would be distributed in proportion to one less this ratio. These two methods of cost allocation are illustrated as follows:

b_i = estimated benefit of each of the n reaches of the aqueduct

C = total cost of aqueduct

ϕ_i = separable cost of reach i ($C - C_{a \ldots h,\, j \ldots n}$), or difference between total cost of entire aqueduct less its cost if delivery to reach i is excluded.

a_i = cost of aqueduct to serve only reach i

$Y_i = b_i - \phi_i \mid b_i < a_i$, or $a_i - \phi_i \mid b_i > a_i$

U_i = degree of use of total facility occurring in reach i (annual acre-feet delivery to reach i)

Ω = remaining benefit (assuming economies of scale exist) = $\sum_{i=1}^{n} \phi_i - C$

Cost allocated to reach i by separable-cost-remaining-benefits method =

$$\phi_i + \left(1 - \frac{Y_i}{\sum_{i=1}^{n} Y_i}\right) \Omega$$

Cost allocated to reach i by proportionate-use-of-facilities method =

$$\phi_i + \left(1 - \frac{U_i}{\sum_{i=1}^{n} U_i}\right) \Omega$$

[2] It is estimated that the southern California coastal plain and coastal San Diego County would receive 63 per cent of the total present worth of primary benefits of each of the three alternative routes of the southern California aqueduct. See: Department of Water Resources, Preliminary Summary Report on Investigation of Alternative . . ., Tables 27, 28, and 29.

If zonal price differentiation is combined with preconstruction contract guarantees,[1] the incremental costs of southern water diversion will be covered by revenues from water sales, eliminating the possibility for facility over-expansion. A number of technical problems, however, accompany this proposal. If a zone north of the most southerly zone served indicates an unwillingness to contract for amounts of water adequate to assure receipts to the regional authority equivalent to costs, does this influence the size of contract payments to the more southerly zone? Will their costs be adjusted to cover the delinquent zones' excess costs? Are these excess costs to be amortized over all other potentially "solvent" zones along the distribution system?

This eventuality appears distinctly possible, especially if a differentiation of price among different uses is made by local agencies. The Southern California Metropolitan Water District already has existing mechanisms for such a differentiation, effectively shifting cost incidence to urban or industrial areas by ad valorem property assessment. Although individual irrigation districts also have this power, their limited size would probably require a federated organization for effective intrazonal price differentiation by use. The southern California coastal plain would be able to shift a larger portion of zone's cost to the urban and industrial uses than would the Central Valley areas, as previously noted. Such a reduction of agricultural water costs might disrupt the current interregional patterns of agricultural competition within the state.

Conceivably, such a change in regional production may be economically efficient. This would be the case if the marginal value product of agricultural water were greater in southern California than in the San Joaquin Valley. If the urban center-agricultural hinterland thesis[2] is accepted, the intraregional shift of water cost incidence from agriculture to municipal and industrial water

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[1] The California Department of Water Resources recently announced the following policy: "Construction of any transportation facility financed wholly or in part through the sale of bonds, will not be started unless water service contracts have been executed which will insure recovery of at least 75 per cent of the cost of such facility." See: California Department of Water Resources, "Contract Principles," Contracts, Financing, Cost Allocations . . . for State Water Development (Sacramento, 1960), p. 53.

[2] This thesis maintains the organic unity of urban centers and the agricultural area immediately adjacent thereto as units of social organization. Although primarily employed for purposes of sociological analysis, economic derivatives of the thesis have been used in the analysis of communities in the San Joaquin Valley of California. See: W. R. Goldschmidt, "Social Structure of a California Rural Community" (unpublished Ph.D. dissertation, Department of Anthropology, University of California, 1942).

users would not impair the efficiency of agricultural production, as the urban area (comprising mainly municipal and industrial water users) is considered an integral part of regional agricultural production. If this thesis does not hold, the postulated agricultural production shift would represent a net loss of regional real income. Whether this thesis is appropriate for southern California is open to question. If the industrial-urban concentration of the south coastal plain represents a self-contained economic unit whose functions are independent of an agricultural hinterland, the postulated shift in agricultural production would not satisfy optimal production conditions.

This admittedly is a static interpretation of efficiency. The willingness of southern California municipal and industrial water users to bear part of the cost of agricultural water doubtless reflects their desire to establish current use of this water. It will be available to the entire region at some point in future time when a substitution of expanded municipal and industrial water uses for former irrigation use is anticipated. In this sense, the marginal value product to this part of the state would be adequate to warrant the current underwriting of agricultural costs by municipal and industrial water uses. This still does not assure a situation of economic efficiency for the state's total economy. The organization of water agencies through the Metropolitan Water District permits a longer time horizon for the conception and estimation of a marginal value product of water than is afforded the Central Valley organizations. Such assurance would require comparable planning horizons on the part of organizations in both parts of the state.

Price Variations Over Time

The initial financing proposals for the California Water Plan envisage the issuance of 50-year, general obligation bonds. The length of delivery contracts anticipated also is 50 years. A variable acre-foot charge for contracted water during this 50-year period has been proposed. This proposal reflects the desire to receive payment commitments adequate to assure project solvency prior to state construction on one hand and uncertainty with respect to the actual construction cost and immediate effective demand for state water on the other.

To the extent that a variation of contract price is passed on by a district to its members through the payment complex, contract water assumes cost attributes for the eventual consumer similar to those of pumped ground water. A basic difference would be that cost changes of pumped ground water are associated with physical conditions of the ground water aquifer and power costs.

As the latter are relatively stable by virtue of public utility rate regulations, future cost changes may be estimated by the analysis of past and current ground water conditions. Variations in the price for state water would have different, and not necessarily as predictable, determinants with the possible consequence of higher on-farm costs of sudden adjustments to price changes. This could be minimized, however, by announcing cost estimates for future periods of delivery or stipulating maximum and minimum limits to such future cost changes.

From the standpoint of contracting districts, some guarantee is needed to assure that its solvency can be maintained under a flexible price contract--some effective ceiling would have to be specified. The inability to project the eventual level of a district's future payment to the state renders the schedule of payments adopted for its members subject to future change. Prior to contracting for water from a regional water development program, a district's future water demand must be estimated. Districts anticipating an expansion of current demand--as the result of either members substituting additional surface water for presently pumped ground water or the expansion of irrigated acreage within the district--will attempt to contract for a quantity consistent with estimated future demand. If the average acre-foot payment of the district to the regional authority increases to a point at which the associated internal payment complex removes the inducement to expand internal irrigation, the district would have overcontracted in terms of effective member demand. Under such conditions, it would have to sell whatever possible of its excess water to nondistrict entities. Although there are at present no restrictions on such extradistrict sales, nondistrict demand for such water generally would tend to be lowest during those times when the largest surpluses would accrue.1/ Failing to dispose of its excess water by nondistrict sales, the additional revenue to the district needed for contract payments would have to be exacted from members by increasing either the water toll, or assessment, or both. Thus, such a pricing device conceivably could result in a higher cost for water to individual water users than would be the case under a fixed contract payment.

From the standpoint of the regional authority, flexibility of price over time constitutes protection against the impairment of its credit by project financing arrangements. This follows from uncertainty surrounding structure and

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1/ Due to the planned capacity use of facilities to each service area, such nondistrict sales would be limited to the same general service area in which the selling district was situated. Presumably, fluctuations in the demand for irrigation water would be similar throughout the general service area, rendering the selling district at a relative disadvantage. To the extent that interservice area sales of excess deliveries are possible--these would appear possible prior to full over-all project delivery--this relative disadvantage might be mitigated.

As the [illegible] are relatively small by virtue of public utility rate structures, future cost changes may be estimated by the analysis of past and current [illegible] market conditions. Variations in the price for [illegible] water would have [illegible] necessarily on [illegible], determinants with the possible consequence of [illegible] on-farm [illegible] adjustments to water payments. This could be mitigated, however, by announcing cost estimates for future periods of [illegible] of stipulating maximum and minimum limits to such future cost changes.

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From the standpoint of the regional authority, flexibility in rates [illegible] some considerable protection against the [illegible] of the [illegible] arrangements. This follows from [illegible]

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[1] [illegible] the planned [illegible] [illegible] would be [illegible] the [illegible] price [illegible] which the [illegible] water would [illegible] the general [illegible] the [illegible] district [illegible] a [illegible]. [illegible] the [illegible] be [illegible] [illegible] over-all [illegible]

facility cost estimates and the uncertainty of future effective demand by districts and the size of future fund transfers. Should these costs substantially exceed present estimates or should current estimates of general obligation bond interest be incorrect,[1] the regional authority might have to repay bondholders from general fund moneys or resort to general taxation. Both lines of recourse would impair its credit position as well as violate beneficiary payment criteria.

In the absence of price flexibility, the risk of increasing costs is effectively incident upon the regional authority. This is not necessarily consistent with the enhancement of regional income. Absence of this risk at the district or the consumer level precludes an effective stimulant to agricultural adjustment in connection with factor cost change and thus may freeze existing water use in patterns rendered inefficient by such change. Variation of price over time would, however, provide the regional authority with a means whereby adjustment of individual enrichment from public water development could be achieved continuously. Such enrichment may be expected to change over time with technological change and shifts in the relative prices of associated inputs.

A more significant aspect of price variation over time relates to the stimulation of water use in particular areas that is consistent with over-all economic planning of a region. For example, if, after the California Water Plan is constructed, an industrial or urban expansion is desirable in a particular area, flexible pricing would permit a payment change to be used as an inducement to such expansion.

Benefit Pricing

The final pricing method to be examined is one based upon benefits received. Conceptually it requires knowledge about the demand function for water, and in application it entails prices resembling those of a perfectly discriminating monopolist. So long as the demand functions of separate local districts are not equally elastic with respect to price, sales receipts are maximized by this pricing method. This elementary theorem of economics refutes the widely held position that only a price related to allocated costs can assure project solvency.[2] This latter formulation in no way guarantees solvency,

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[1] As bond issues within the total authorization would be sold as the principal becomes required for capital outlay, the interest rate for particular issues will vary.

[2] Assembly Interim Committee, Economic and Financial Policies for State Water Projects, Assembly Interim Committee Reports for 1959-1961 (Sacramento, 1960), vol. 26, no. 1, chapter II, p. 14.

whereas actual financial solvency of the state is increased by such a benefit pricing system. This derives from the fact that offers to contract will be conditional upon the relationship between established price and value attributed. A cost established in excess of this value will have no bidders and hence no sales receipts, regardless of whether its formulation is by a cost base or any other type of base. Thus, the solvency position of the state depends on the cost-based price being not greater than the value of water in all instances of actual delivery. Where this is not so, repayment by sales receipts would be incomplete.

Frequent attempts are made to analyze water use activities within potential service areas so as to guarantee such a favorable relationship of cost based price to benefits. However, the magnitude of benefits is difficult to estimate and is subject to change with variations in the expectation of future events as well as with changes of factor price and technical conditions of production. Regardless of the fact that the estimation procedures used by regional agencies appear to be somewhat lacking, the susceptibility of benefits to change demonstrates forcefully the need for price to reflect value changes--not merely the performance of certain water accounts or cost allocations. Benefit pricing requires such changes as future events and behavior show them to be necessary. On the other hand, the tendency toward inflexibility of prices tied to other computational bases works against such change in pricing conditions.

This method also would localize charges on beneficiaries. They would be progressive, or proportionate to real benefits received, tending toward an equalization of net benefits received. This generally is consistent with the prevention of unjust enrichment.1/

At the local level, benefit pricing may result in limiting the flexibility of internal district pricing arrangements. It would certainly limit this flexibility if resale stipulations were introduced into water delivery contracts, or if such a pricing method were imposed by regional authority directly upon consumers. This extreme interpretation of benefit pricing has associated problems relating to the ability of the regional agency to assess the value of water to individual district members or internal groups. Considering each district a production unit, while imputing to it a unit water benefit, appears to

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1/ Benefit pricing would be consistent with interpretation 4 of unjust enrichment (see footnote 4, page 9), neutral with respect to 1 and 2, and inconsistent with interpretation 3 if the absolute amount of enrichment to be retained is constant for all uses and users.

be the most feasible manner in which the principle could be rendered effective. This would provide the basis of the size of payments for individual district contracts and would leave the district its present flexibility in using the payment complex for internal pricing arrangements. Approximative measurement procedures, using the cost to particular organizations of alternative supplies as a confining limit to these benefits, suggests the district as the logical unit for analysis as well as administration of such a pricing method.

The value of benefits may be taken as a weighted average of benefits or marginal value product to individual water uses and users occurring within its boundaries. Technically each district would have a different average benefit, but in practice ranges could be established into which recipient organizations could be grouped. The geographical configuration of actual payments resulting from this price tool would parallel that derived from a zonal price differentiation. For example, in the case of the California Water Plan, each of these tools would result in average acre-foot payments increasing to the south. In one case, this results from the allocation of aqueduct system cost, in the other from the increasing limitation on alternative water supplies in that direction.

From the standpoint of water tenure uncertainty, value pricing appears to have positive attributes. This is particularly true for those contracting districts with appropriative water rights. If the quantity of water contracted, in addition to that from other district sources, exceeds effective demand, the possibility of prescriptive capture because of nonuse presents itself. Under benefit pricing arrangements, the price charged presumably will assure a ready local market and reduce the tenure uncertainty of district water from sources other than by contract.

A further advantage from the district standpoint of such a pricing method is that the direct link with benefits implies an automatic price adjustment geared to the particular phase of the business cycle prevailing at a given time. It would provide protection against the wholesale foreclosing experienced in many districts during the national depression when water payments were not adjusted accordingly.

III. Pricing Methods and Water Policy

The close relationship between water pricing and a number of important water policy issues may be made explicit by considering the three major areas of water

policy issue: project evaluation and selection, financing and repayment, and water law and organization.[1] Water pricing is but one aspect of the second category, yet is closely interdependent with the other two. Forms of payment and conditions of proprietory transfer are partly determined by water organization and law. Should a payment method be adopted that precludes a specific type of previously existing use, the calculation of benefits and costs needed to reach decisions of project selection must be recomputed. This in turn may alter the priority ranking of alternative water projects. Pricing thus is not an isolated matter to be resolved after other policy decisions have been made. Relevant analysis of public investment alternatives must consider methods of product payment.

Public investment activities[2] can be justified by the failure of private investment actions to satisfy social criteria. The composition of the private investment, its aggregate size, or its timing may be inconsistent with these criteria. Of the several causes for this failure that have been indicated,[3] two are of immediate relevance to water pricing methods. These are price signal failures due to indivisible proprietorship and inconsistency between private and public time preference rates.

Proprietary Indivisibilities

Indivisibilities in water "ownership" may be of two types: indivisibilities in quantity and over time. Both categories are considered. A reduction of these indivisibilities facilitates proprietary transfer and thus potentially enhances the efficiency of the resulting water allocation. Reduction of quantitative indivisibilities tends to deter the development of a noncompetitive market environment wherein such transfer may occur. Reducing temporal indivisibilities increases the frequency of opportunities for water reallocation.

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[1] Implicit recognition of these policy categories is evident through the standard "tests" used by federal agencies. Economic justification and financial feasibility relate to the first two categories. More pragmatic tests in the form of local organization eligibility standards include the third.

[2] Public investment activities refer to more than the substitution of decision agents; it also embraces the determination of the physical dimensions of the capital good to be created and relevant administrative decisions such as pricing methods.

[3] Wantrup recently has identified six forms of price breakdown particularly relevant for natural resource development. Ciriacy-Wantrup, "Social Objectives of Conservation of Natural Resources with Particular Reference to Taxation of Forests," Taxation and Conservation of Privately Owned Timber (Eugene, 1959), pp. 1-70. (Conference Proceedings, Bureau of Business Research, University of Oregon, January 27 and 28, 1959.)

Although in itself not sufficient, the ability to redefine proprietary interest is a necessary condition to such a reallocation.

A reduction of these two types of indivisibilities at the wholesale level may be considered as an increase in the negotiability of water delivery contracts. Such negotiability bears directly upon the problem of water transfer in connection with secular economic adjustments of agriculture. It would permit water delivery contracts between the regional authority and a local district to be sold. Obviously, concurrence by both entities would be required to allow the transition to be incorporated into the delivery schedule of the former and avoid overcapacity demands on the aqueduct system. Similarly, a legal transfer of liability for payments to the state during the remaining life of the contract would require agreement of all parties. Under these provisions, however, use of negotiable contracts would contribute to the economic efficiency of the operation of a regional program of water development and distribution. Particular advantage is seen from the standpoint of facilitating adjustment among water using activities on the one hand and water supply organization on the other. That is, the proprietary interest may be shifted as different forms of local distributive organizations appear more suitable in light of future changes in the pattern of water use. Different forms of local distribution organization may be desired as a result of such a change in the use pattern, or they may be adopted specifically to induce those changes that are deemed desirable. Avoidance of lags in these shifts, resulting from a relatively fixed allocation of water supply, would be facilitated by this tool, permitting the more immediate realization of the increments in real income implied by the shift in the pattern of water use.

The negotiable contract per se would not tend toward equity problems. Linked with provisions for a centrally imposed assessment upon a new contract recipient, the cost to local organizations effectively could be varied so that a portion of consumer's surplus could be captured. Indeed, if the transfer implied no major change in the use pattern of the eventual consumption of that water, no assessment would be indicated. If, however, a basic change in type of use was involved, the assessment would provide one mechanism for the confiscation of a larger portion of the marginal value product of that water which may be assumed to exceed that of the previous water use pattern. Thus, such negotiability would be deterrent to unjust enrichment problems if coupled with a centrally imposed contract transfer assessment.

An increase in negotiability also would tend to strengthen the credit position of the regional authority. It would facilitate the transfer of active

contracts from organizations financially insolvent to others with a stronger financial position and thus considerably strengthen the collateral for future contracted payments to the authority. If the organization petitioning as transferee had an inadequate financial position, state approval could be withheld and the transfer prevented.

Such a provision would induce a market for contracts and thus provide data enabling a more precise estimate of the value of its assets than would be the case if such a value were imputed. If price adjustments are to be made at some point during the life of the contract, as accurate information as possible on the asset value of outstanding contracts would materially assist in determining the magnitude and direction of such changes consistent with the over-all solvency position of the regional program.

The 50 years' liability and service commitment assumed by districts contracting from the California Water Plan may be commuted by sale of the contract. This is particularly important in light of the anticipated population expansion of California during the next 50 years and the attendant adjustments in water use that will accompany this growth.

Two aspects of this adjustment are significant: (1) the adoption of new forms of organization and (2) the changes in the financial base of local districts. Past experience of California irrigation districts evidences the difficulties of using this form of organization to construct, finance, and administer extensive systems of domestic water supply. Most of these districts had assumed an initial function of providing irrigation water service. With the subdivision of previously agricultural land within their boundaries, many districts were faced with the need to provide domestic service in substantial quantity. Public health regulations requiring either a sanitation treatment of all district water or the construction of entirely separate domestic systems caused financial difficulties in a number of districts, especially during the early phases of such transitions in water use. In many instances, new urban areas within irrigation districts established their own domestic water supply agencies, frequently purchasing water at wholesale from the district. Contract negotiability would facilitate the use of more adequate forms of organization dictated by the evolving conditions. It would not freeze the incidence of risk and uncertainty of meeting state payments on the older district and would simultaneously reduce price uncertainty of that water to the newer organization.

The changing financial base of local water districts likewise makes the negotiable contract desirable. Should this base become restricted, as occurred throughout western United States during the depression of the 1930's, the district may attempt to alter its operations in response thereto. The fixity of delivery quotas and the cost incidence of a nonnegotiable contract curtail the ability of the district to so adjust.

Discrepancies Between Private and Public Time Preference

Time preference rates conceptually express the ratio of marginal monetary utility at the present time with some point in the future. Such utilities are summary expression of a host of real and illusory variables. No attempt is made to summarize the research into the specific functional relationships involved. Two generalizations are accepted and related to water pricing. First, the aggregate nature of a region, defined as consistent with the regional authority, may be characterized by time preference rates that differ from those of the largest private investment agents within the region or to the weighted average of such rates of all private investment agents therein. It further is accepted that changes in public time preference differ in magnitude, timing, and possibly direction from private rates. Plausibility of these assumptions derive from the influence of custom and habit pattern on what is generally considered "private" as opposed to "public" investment responsibilities.

Without the means to specify the character of these differences--and they must be so specified as must the changes in external influences on prices for optimization of the public-private investment mix--one may point to the need for project flexibility. This flexibility may be included through physical project design as well as through administrative and operative practices. Although such flexibility will almost certainly involve costs, failure to adapt to future conditions and changed objectives may incur substantially greater costs. The problem of identifying the economic margin of buying program flexibility is an interesting analytical problem to which little professional attention has been devoted. In the absence of formal criteria to indicate the optimal degree of flexibility, one merely may stress the importance of the condition and consider the extent to which various pricing tools are conducive to such flexibility.

Physical flexibility relates to the adaptive capacity of the physical system of the Plan to future changes in physical proportions. Variation in the initially proposed delivery schedule may require change in the capacity of

designated portions of the southern California Aqueduct System. The extent to which such changes can be made in the future and their cost provides an index of the Plan's physical flexibility.

Administrative flexibility is desirable for obvious reasons. Inaccuracy of future cost estimates, changing structures of local organizations, or changing water use patterns may make changes in cost and water tenure conditions desirable. Equally obvious is the fact that provisions for administrative flexibility must make allowance for certain guarantees to contractees. The incidence of risk among the various agents entailed in the pricing procedure is a basic determinant of their time preference and planning horizon. If proposals for administrative flexibility entail subjecting individual districts or their consumers to a large uncertainty with respect to their future net returns from water-using activities, the time preference of those agents will be increased and their planning horizon decreased accordingly.

The extent to which any area-wide agency can shift the risk incidence to more local agents depends, of course, on its relative political strength and the number of alternatives available to the potential contractees. The optimal incidence of cost uncertainty cannot be specified on any a priori grounds. The capability of a local agency to absorb uncertainty depends upon its organization and its financial foundation--its recourse to bonds, other forms of credit, and liability to obligations undertaken. In California, with its relatively advanced organization of local water districts which have the power of assessment and the recourse to receivership by a special state agency designed purposively as a way of avoiding bankruptcy proceedings,[1] more cost uncertainty can be tolerated than in a state where the ability to hedge and the degree of financial protection are not afforded.

A final remark relates to the status of state pricing policy at the end of the 50-year contract. What provisions for recontract, price, and quantity variations are to be made? Consideration of this problem accepts a premise pertaining to the relationship between public water development and the broader concept of economic planning.

As discussed above, the economic rationale of the California Water Plan is inferred as the increase of net productivity of the state. Although current debate considers water development relatively in isolation from other aspects of the California economy, frequently public resource development programs are integrated with general economic planning.

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[1] The California Districts Securities Commission.

It is submitted that, although there is presently little public attempt to relate such development to economic planning, the future will see this relationship growing in political and economic importance. The purposeful use of water--or other resource development activities--to induce particular patterns of population and economic activity may be reasonably expected to become a more prominent issue for research and practical implementation.

If such a future trend is anticipated, current proposals for state pricing policy must be made as accommodating as possible to future changes that will permit the integration of the administration of the California Water Plan into the broader scope of economic planning.

In light of this, recent proposals1/ to grant perpetuity contracts appear as an inappropriate public pricing tool. The continued service by the state under essentially similar conditions as the initial contract would appear consistent with the enhancement of state income. If contract receipts exceed total costs of the California Water Plan, these receipts would appropriately be paid into the general fund of the state and thus be available for public reinvestment. Furthermore, additional outlays undoubtedly will have to be made in connection with the Plan.

1/ See: California Farm Bureau Federation, California Farm Bureau Monthly, Resolution No. 45, vol. 41, no. 1, January, 1960, p. 24.